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DETERIORATION OF AIRPLANE FABRICS

By

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33nd Report of the German Experimental Institute for Aviation at Berlin-Adlershof.

The observation that airplane fabrics, after long use, lose their original strength, caused the German Experimental Institute for Aviation to carry out a series of experiments on the effect of weathering on the cloth covering of airplane wings and fuselages.

An air traffic company furnished, for this purpose, "doped" and painted fabric which had been used on the wings and fuselage of a military airplane converted into a traffic airplane. It may be assumed that the wing fabric originally conformed to the specifications of the "Flugzeugmeisterei" (technical airplane section). At that time, the stipulations for undoped fabric, when the warp was parallel to the ribs, required a tensile strength of at least 700 kg/m in the direction of the warp and of at least 1000 kg/m in the direction of the woof; also that the elongation should not exceed 12% in the direction of the warp, nor 7% in the direction of the woof. Doping increased the tensile strength about 50%, or to about 1050 and 1500 kg/m respectively.

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* From "Zeitschrift für Flugtechnik und Motorluftschiffahrt," November 30, 1931, p. 325.

The tensile tests were made with a fabric-testing machine constructed by the Schopper Company in Leipzig. Both tensile strength and elongation were determined. The free length of the tested strips was 20 cm. Since it was impossible, in these strips, to distinguish the direction of the warp from that of the woof, no test could be made in this respect. The results of the tests are shown in the tables.

Sample I: Old doped airplane fabric from the bottom of a left upper wing with gray and black paint already beginning to scale off.

No. of Test	% Elongation	Tensile strength in kg/m
1	3.6	1200
2	4.8	1160
3	4.0	1173
4	3.6	880
5	4.0	1033
Average	4.0	1089

Sample II: Old doped airplane fabric from the top of a left upper wing, with gray paint already scaling badly.

No. of Test	% Elongation	Tensile strength in kg/m
1	4.7	550
2	4.0	444
3	4.4	486
4	4.2	486
5	4.0	533
Average	4.0	499.8

Sample III: Old doped airplane fabric from the fuselage, with green paint beginning to scale.

Series (a)

No. of Test	% Elongation	Tensile strength in kg/m
1	3.6	1000
2	4.2	1050
3	8.0	1112
4	6.7	764
5	7.3	913
Average	5.96	947.8

Series (b)

No. of Test	% Elongation	Tensile strength in kg/m
1	9.8	803
2	8.7	954
3	4.0	996
4	8.8	767
5	3.2	1164
Average	6.9	936.8

While, as shown by Table I, the fabric from the bottom of the upper wing still had a tensile strength of 1089 kg/m, the sample from the top of the upper wing, which was most exposed to the weather, had a tensile strength of only 499.8 kg/m. which must be considered much too small for a doped fabric. The tensile strengths of the fuselage covering (Tables a and b) varied between 937 and 948 kg/m. It is not impossible that the fuselage covering may have been of poorer quality than the wing covering, as it only had to afford protection against wind and weather and was not subjected to great stresses.

The tensile strengths stipulated by the "Flugzeugmeisterei" were fully great enough. Pröll demonstrated in his experiments, instituted by the "Flugzeugmeisterei," that tensile strengths of 700 to 800 kg/m in the weaker direction was fully sufficient for undoped wing fabrics.*

As already mentioned, the samples tested were covered with a coat of paint. This served to advertise the air traffic enterprise and to awaken an interest on the part of the passengers. Unfortunately, however, when not employed with the necessary technical knowledge and caution, the paint may constitute a great source of danger, for it is a simple and sure means of quickly and easily concealing many defects of the wings, like tears, peeling patches and badly weathered spots and sometimes so as to deceive even the experienced eye. Herein lie great dangers and disadvantages for the airplane, and eventually for air traffic.

It cannot be regarded as a means of strengthening old doped fabric, although it seems to have sometimes had that effect, as the paint does not combine with the dope. There is rather in flight a reaction of the two substances against each other, which causes the paint to scale, especially on top of the wings. Weathering influences, such as moisture, heat variations and wind, vortex motions of the propeller stream and the lift-generating suction gradually destroy the fabric.

* Technische Berichte der Flugzeugmeisterei, Vol. III, p. 382, published by R. C. Schmidt, Berlin.

Fatigue phenomena*, which appear especially after great stresses during flight, and are indicated by slackness of the doped fabric covering, likewise cause gradual deterioration. Pröll demonstrated experimentally** that the fabric, when freed from the load to which it had been subjected for a long time, was at first slack and almost devoid of elasticity. This condition was however of short duration. The fabric recovered its previous elasticity to a certain extent, indicating a good quality of dope.

A good paint should supplement the dope to a certain degree and reduce the moistening of the fabric to a minimum. The German Experimental Institute for Aviation is about to undertake further experiments on the availability and behavior of paint as a strengthening coat and will report later.

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* Compare C. G. Gray in the Aeroplane of October 5, 1921, No. 14, pp. 293-296, and p. 307.

** "Zeitschrift für Flugtechnik und Motorluftschiffahrt," January 31, 1920, p. 20.